# Air Quality Monitoring

## Turner Valley Historical Gas Plant

**November 23rd and 24th, 2005** **Final Report**

### *Introduction*

The town of Turner valley is a community of 1608 (2001 Census ) located in the foothills of the Canadian Rocky Mountains. This is the birthplace of Alberta's oil and gas industry. The turner valley gas plant started operating in 1914 when wet gas[1] was discovered in the area. The plant was decommissioned in 1985 and is currently owned by Alberta Community Development and maintained as a National Historic Site. A number of environmental investigations have already identified hydrocarbon impact on soil and water in the vicinity of the gas plant[2]. Furthermore, there are known seepages in the area that can release hydrocarbons into the air. Currently there is one ground flare in place to convert seeping hydrocarbons into the more desirable carbon dioxide ($CO_2$) and water vapour.

To assess the quality of air in the area of the historical gas plant, Alberta Environment's mobile laboratory (MAML) conducted a survey for two days during the fall of 2005. The MAML is equipped to measure hydrocarbons as well as ammonia, carbon monoxide, oxides of nitrogen, ozone, particulate matter, reduced sulphur compounds and sulphur dioxide. In addition to the MAML measurements, air samples were collected for quantification of volatile organic compounds (VOCs).

The main objectives of the study were to quantify atmospheric concentrations of hydrocarbon in the area of the historical gas plant, and determine the most abundant VOCs. Measurements were conducted at a number of locations including downwind of the historical gas

[1] Wet gas is a mixture of hydrocarbons containing less methane (than dry natural gas) and more propane and butane.

[2] Turner valley gas plant: Surface Water and Ground Water Monitoring. Prepared by C5 Engineering Ltd. for Alberta Infrastructure, October 18, 2005.

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plant and ground flare. Concentrations measured downwind of the historical gas plant were compared to hydrocarbon concentrations measured at upwind and background sites. Alberta Environment has ambient air quality objectives for a number of VOCs; when available, measured concentrations are compared to these objectives.

There are plans to conduct further monitoring in the area in the winter of 2007. At this time, monitoring will be conducted with and without the ground flare in place.

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**March 6, 2007**

## *Overview*

Total hydrocarbon concentrations were elevated downwind of the historical gas plant. Both methane and reactive hydrocarbons were relatively high at this site. Median methane concentration downwind of the historical plant was 7.2 ppm. At all other monitoring locations methane concentrations was approximately 2 ppm, a concentration comparable to background methane concentration observed at many other MAML measurements. Median reactive hydrocarbon concentration downwind of the historical plant was 2.7 ppm; concentrations at all other monitoring locations were at, or below, the detection limit of the instrument onboard the MAML.

VOCs analyses of air samples taken downwind of historical gas plant and ground flare revealed that concentrations were notably higher at these two sites. The most abundant VOCs were from the alkane family, with propane and butane having the two highest concentrations. Propane concentrations downwind of the ground flare, historical plant and at the background site were 2759.40, 943.72 and 1.46 $\mu g/m^3$, respectively. Elevated hydrocarbons downwind of the historical plant were most probably the result of fugitive emissions (ground seepage). There are no AAAQO for the most abundant VOCs; where there were objectives, none were exceeded.

Median $SO_2$ concentration of 0.002 ppm downwind of the historical gas plant was somewhat higher than background levels. At almost all other monitoring locations median $SO_2$ concentrations were below the detection limit. Intermittent and short-term increases in $SO_2$ concentrations were measured at Sites 1 and 3. Maximum measured concentrations at these two sites were 0.036 ppm (**Site 1**) and 0.035 ppm (**Site 3**). A common feature of these two sites is that they are both downwind of the Talisman compressor. The burning of vented gas, as in the case of the ground flare at the historical plant and the occasional flaring at the Talisman compressor probably produced the small amount of $SO_2$ measured at these sites.

Elevated PAHs concentrations were measured at three locations around Turner Valley. PAHs concentrations measured northwest of the Town of Turner Valley was most probably due to vehicle emissions. Median PAHs concentration of 16 $ng/m^3$ was measured at this site. In addition to elevated PAHs, nitric oxide (NO) concentrations were also relatively high at this location. NO is typically associated with vehicle emissions. Elevated concentrations at the other two locations, downwind of the historical plant and downwind of Talisman compressor, could not be linked to vehicle emission by association with simultaneously high NO

concentrations. The median concentration at these sites (6 ng/m$^3$ and 5 ng/m$^3$) were relatively lower than observed northwest of Turner Valley but were notably higher than the concentrations measured upwind of the historical gas plant (1 ng/m$^3$).

## *Monitoring methods and locations*

The Turner Valley air quality survey had two components, Alberta Environment's Mobile Laboratory (MAML) and canister samples of air that were analyzed for volatile organic compounds (VOCs). Pollutants measured by the MAML include: ammonia, carbon monoxide, hydrocarbons, oxides of nitrogen, ozone, particulate matter, reduced sulphur compounds and sulphur dioxide. One-minute average of each of the parameters was available for analysis. Samples were also taken by drawing air into a 6 L stainless steel canisters at a constant rate for an hour. This integrated sample was later analyzed for 185 VOCs; the concentrations quantified are an average for the sample hour. Analyses were performed by Environment Canada's air toxics laboratory in Ottawa.

Monitoring locations were chosen such that the impact of the historical gas plant as well as nearby compressor station (Talisman Energy) could be examined. The choice of MAML monitoring site can be limited by available access and meteorological conditions. For the current survey, a number of downwind sites as well as upwind and background sites were possible. Table 1 provides descriptions of the monitoring sites. The locations of these sites are illustrated in Figure 1. Operator's comments and meteorological conditions at the monitoring sites are shown in Table A4, in Appendix A.

**Table 1: Monitoring site descriptions**

| Site | Description of site |
|---|---|
| 1 | ***Downwind*** of Talisman Energy (*MAML only*) |
| 2 | ***Downwind*** of historical gas plant (*MAML and VOCs canister*) |
| 3 | ***Downwind*** of historical gas plant and Talisman Energy (*MAML only*) |
| 4 | ***Upwind*** of historical plant (*MAML only*) |
| 5 | Northwest of the town of Turner Valley (*MAML only*) (***upwind of gas plant***) |
| 6 | ***Downwind*** of ground flare at historical gas plant (*VOCs canister only*) |
| 7 | ***Background*** (*VOCs canister only*) |

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| 6 | ***Downwind*** of ground flare at historical gas plant (*VOCs canister only*) |
| 7 | ***Background*** (*VOCs canister only*) |

**Figure 1: Map of monitoring locations (numbered circles), descriptions of locations are given in Table 1.**

## *Results and Discussion*

The discussion in the following sections will focus on measured concentrations of hydrocarbons, sulphur dioxide, polycyclic aromatic hydrocarbons (PAHs) and the most abundant volatile aromatic hydrocarbons (VOCs). Concentrations of these pollutants were notably higher downwind of the historical gas plant relative to concentrations measured at the upwind and background locations. The median concentrations of all the parameters measured by the MAML and concentrations of the 185 VOCs are presented in Appendix A.

One-minute average concentrations collected at the five MAML monitoring locations were used to calculate the maximum, median, minimum as well as the 25$^{th}$ and 75$^{th}$ concentrations of each pollutant at each monitoring site. The 25$^{th}$ percentile indicates the concentration below which 25% of the data occur. In the same way, the 75$^{th}$ percentile is the concentration below which 75% of the data occur. The median indicates the mid value of the data, half of the data set is above the median value and the other half is below. Figure 2 explains the graphical representation of these data. Figures containing these statistics are often useful in depicting the data set as a whole. For example, variability in the data, a significantly high maximum and/or low minimum are readily apparent in these figures.

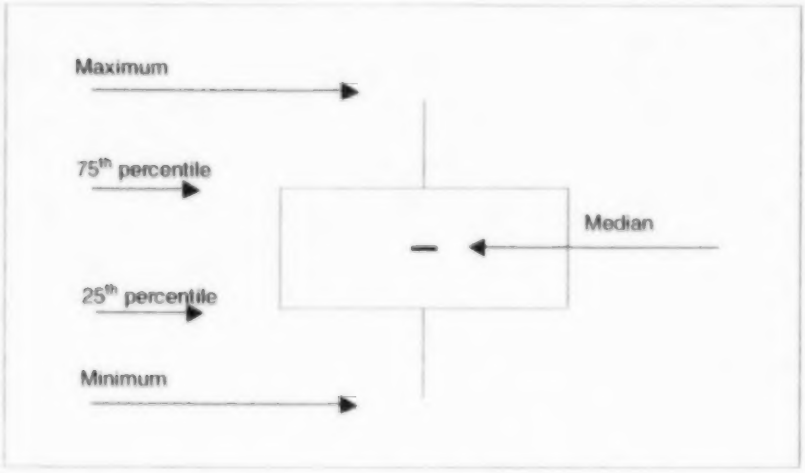


**Figure 2: Key for the interpretation of graphical data.**

## *Hydrocarbons*

The term *total hydrocarbons* (THC) refers to a broad family of compounds that contain carbon and hydrogen atoms. Included in this group is methane ($CH_4$), which is a non-reactive hydrocarbon. $CH_4$ is the most abundant hydrocarbon in the atmosphere. As a result, THC often largely consists of $CH_4$, making concentrations of $CH_4$ equivalent to THC concentrations. The other fraction of THC are reactive hydrocarbons (RHC) also know as non-methane hydrocarbons. RHC are important because they can react in the atmosphere to form ozone. Furthermore, at high concentrations, some chemicals in RHC can be toxic to humans, animals and vegetation. Some major sources of hydrocarbons include oil and gas processing and handling, vehicle emissions and vegetation.

THC concentrations were equivalent to methane ($CH_4$) concentrations at all but one site, **Site 2** located downwind of historical gas plant. The median THC concentration at **Site 2** of 10.4 ppm was approximately five times higher than observed at the other sites (Figure 3). As is evident in Figure 3, even the 25$^{th}$ percentile concentration at **Site 2** was notably higher than the median concentration at all other sites. At all other monitoring locations, median THC and $CH_4$ concentrations ranged from 1.7 ppm to 1.9 ppm. These concentrations are equivalent to level of hydrocarbons measured during MAML surveys conducted in rural areas of Alberta.

In addition to elevated THC concentrations, the RHC fraction was also elevated for samples collected at **Site 2** (Figure 5). The median concentration of RHC at **Site 2** was 2.7 ppm. For measurements performed at all other sites the median RHC concentrations were below the detection limit of the instrument on board the MAML. Elevated hydrocarbon concentrations at **Site 2** were most probably the result of ground seepage. Quantification of the individual hydrocarbons was performed through VOCs analysis. The results from these analyses will be discussed in a separate section.

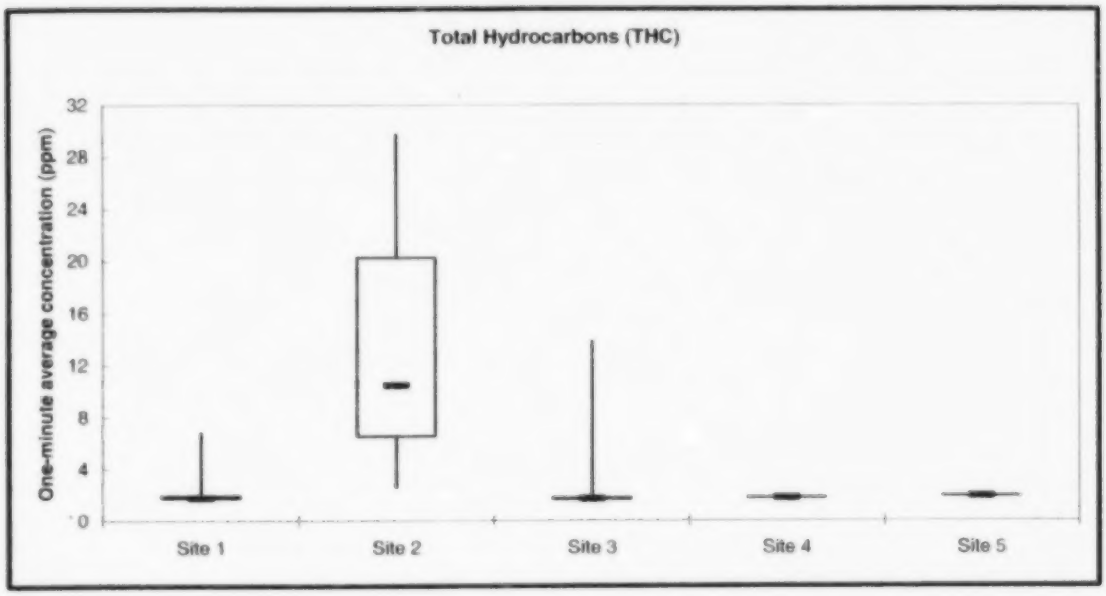


**Figure 3: Total hydrocarbon concentrations measured by the MAML in the area around Turner valley. Minimum, median, maximum, 25th and 75th percentile are presented. A key for interpreting the graphical presentation is found in Figure 2.**

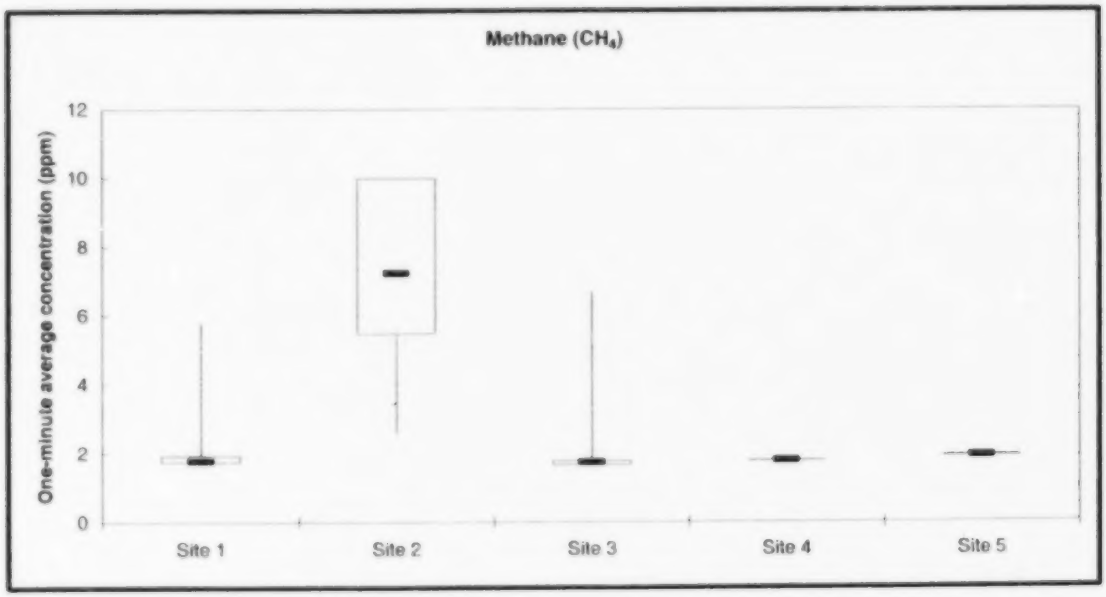


**Figure 4: Methane concentrations measured by the MAML in the area around Turner valley. Minimum, median, maximum, 25th and 75th percentile are presented. A key for interpreting the graphical presentation is found in Figure 2.**

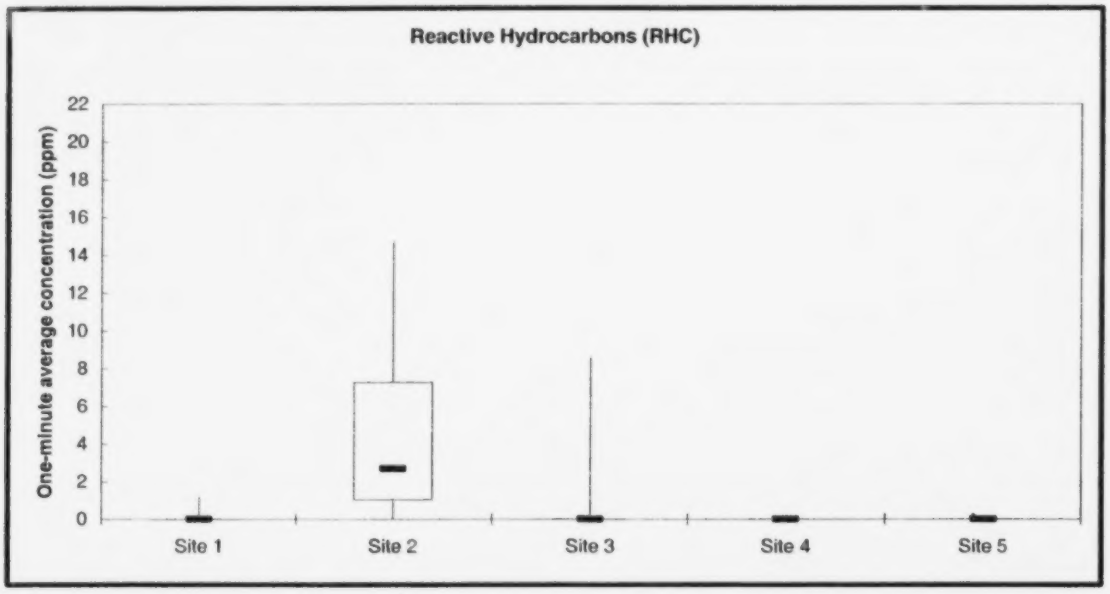


**Figure 5: Reactive hydrocarbon concentrations measured by the MAML in the area around Turner valley. Minimum, median, maximum, 25th and 75th percentile are presented. A key for interpreting the graphical presentation is found in Figure 2.**

## *Sulphur Dioxide ($SO_2$)*

In Alberta, natural gas processing plants are responsible for close to half of the Sulphur dioxide ($SO_2$) emissions in the province. Oil sands facilities and power plants are also major sources. Other sources include gas plant flares (most significantly, sour gas wells), oil refineries, pulp and paper mills and fertilizer plants.

Figure 6 illustrates $SO_2$ concentrations at various locations in Turner Valley. $SO_2$ concentrations at the upwind sites (**Site 4** and **5**) were below detection limit. Short-term elevated of $SO_2$ were observed at **Site 1** and **3**. These two sites had a common feature; they were both downwind of the Talisman Energy compressor station. It should be noted however, that the median and even the 75$^{th}$ percentile concentrations at both these sites were notably lower than the maximum measured concentrations of 0.036 ppm (**Site 1**) and 0.035 ppm (**Site 2**). A median concentration of 0.001 ppm was measured at **Site 1**. The median concentration at **Site 3** was below detection limit. Thus, elevated $SO_2$ concentrations at these sites appear to be intermittent and short-term. $SO_2$ concentrations at **Site 2** (downwind of historical plant) were overall higher than concentrations measured at other sites. There was very little variability in the concentrations measured at this site as is indicated by the small difference between the median, 25$^{th}$ and 75$^{th}$ percentile (Figure 6). However, $SO_2$ concentrations were not significantly elevated with a median concentration of 0.002 ppm. The burning of vented gas, as in the case of the ground flare at the historical plant and the occasional flaring at the Talisman compressor, probably produced the small amount of $SO_2$ measured at these sites. Concentrations reported here are one-minute averages and therefore cannot be compared to the one-hour Alberta's Ambient Air Quality Objectives of 0.172 ppm.

Total reduced sulphur compounds including hydrogen sulphide are also normally associated with petroleum and gas production. However during the Turner Valley survey, concentrations of reduced sulphur compounds were largely below detection limit. The highest one-minute average concentration of 0.002 ppm was measured at **Site 2** and **Site 3**.

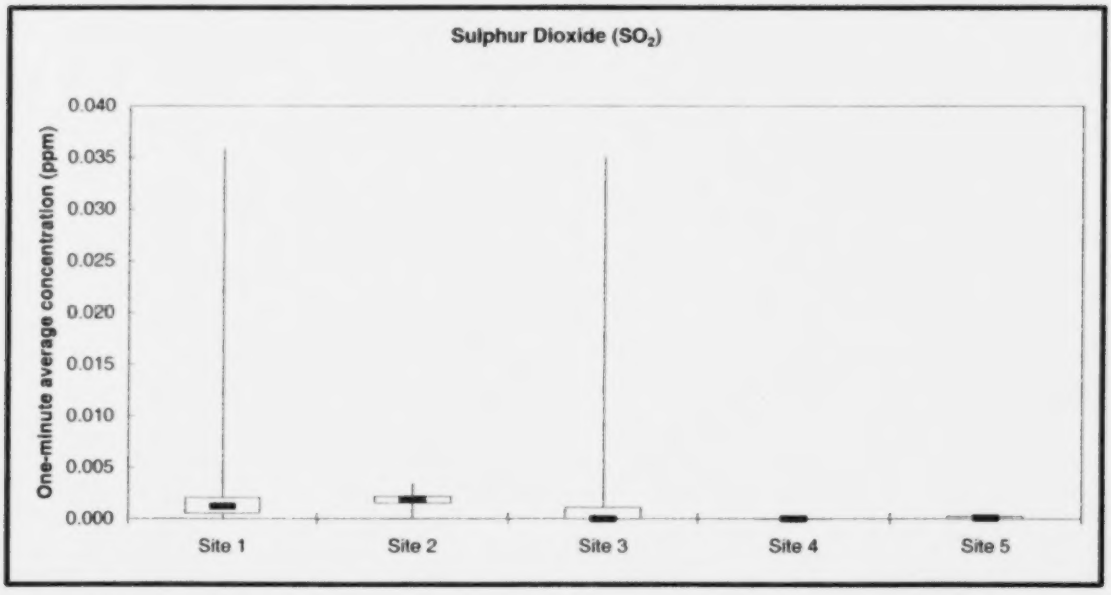


**Figure 6: Sulphur dioxide concentrations measured by the MAML in the area around Turner valley. Minimum, median, maximum, 25th and 75th percentile are presented. A key for interpreting the graphical presentation is found in Figure 2.**

## *Polycyclic Aromatic Hydrocarbons (PAHs)*

Polycyclic aromatic hydrocarbons are organic compound consisting of two or more benzene rings and are formed through incomplete combustion. Ambient sources of PAHs include vehicle exhaust, wood smoke from residential and industrial use and forest fires. PAHs occur as complex mixtures and can be found in the gas phase or condensed onto particles. The phase of PAHs is dependant on ambient conditions such as temperature and the molecular structure of the compound. Larger PAHs (containing more benzene rings) tend to be found in the condensed phase. It is these types of PAHs (condensed) that are measured by the MAML.

The highest PAHs concentration of 70 ng/m$^3$ was measured at **Site 3**. The median and 75$^{th}$ percentile concentrations at this site were significantly lower and comparable to background concentration at **Site 4** (Figure 7). Thus the overall PAHs concentrations at **Site 3** were relatively low.

During the Turner Valley survey, PAHs were elevated relative to background concentrations at **Site 1, 2** and **5** (Figure 7). The median concentration at **Site 4** (upwind of historical plant) was just above the detection limit at 1 ng/m$^3$. Elevated PAHs concentrations at **Site 5** (northwest of the town of Turner Valley) were most probably due to vehicle exhaust. Minimum, median and maximum concentrations at this were 10, 16 and 24 ng/m$^3$, respectively. Indicating an overall elevated PAHs level. Furthermore, oxides of nitrogen ($NO_x$) concentrations were also elevated at this site (Figure 8). $NO_x$ includes nitric oxide (NO) and nitrogen dioxide ($NO_2$). NO is typically associated with fresh vehicle exhaust. At **Site 5** $NO_x$ was primarily composed of NO (See Table A2 in the Appendix A). Where elevated $NO_x$ concentration is found, relatively low ozone ($O_3$) concentration is usually measured. Figure 9 illustrates that $O_3$ concentrations at **Site 5** were generally lower than at the other sites. Overall, the above findings support the assumption that the PAHs source at **Site 5** was most probably vehicle exhaust.

The median PAHs concentration at **Sites 1** and **2** were 5 and 6 ng/m$^3$, respectively. As illustrated in Figure 7, PAH concentrations at this site were variable especially at **Site 1**, where 75$^{th}$ percentile and maximum concentrations, 15 and 37 ng/m$^3$ respectively, were notably higher than the median. Unlike **Site 5**, $NO_x$ concentrations at these two sites were similar to background levels. Median $NO_x$ concentration at **Site 1** was 0.011 ppm and at **Site 2** was 0.013 ppm, compared to a median concentration of 0.007 ppm at **Site 4** (upwind of gas plant). Thus, PAH concentrations at **Site 1** and **2** probably had nearby sources other than vehicle emissions.

**Site 1** was downwind of Talisman compressor and **Site 2** was downwind of historical power plant.

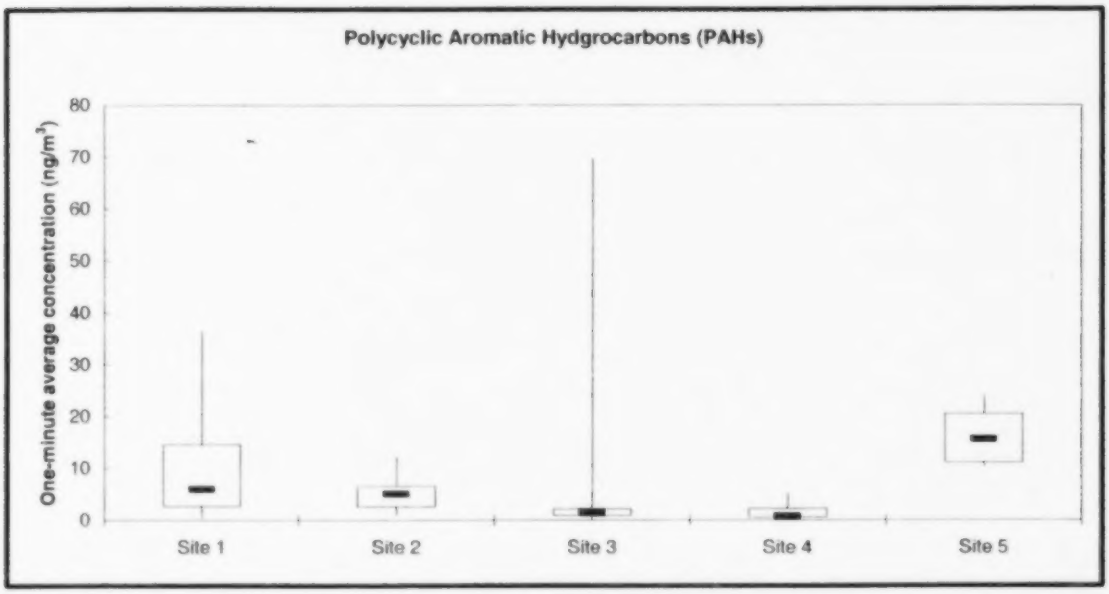


**Figure 7: PAHs concentrations measured by the MAML in the area around Turner valley. Minimum, median, maximum, 25th and 75th percentile are presented. A key for interpreting the graphical presentation is found in Figure 2.**

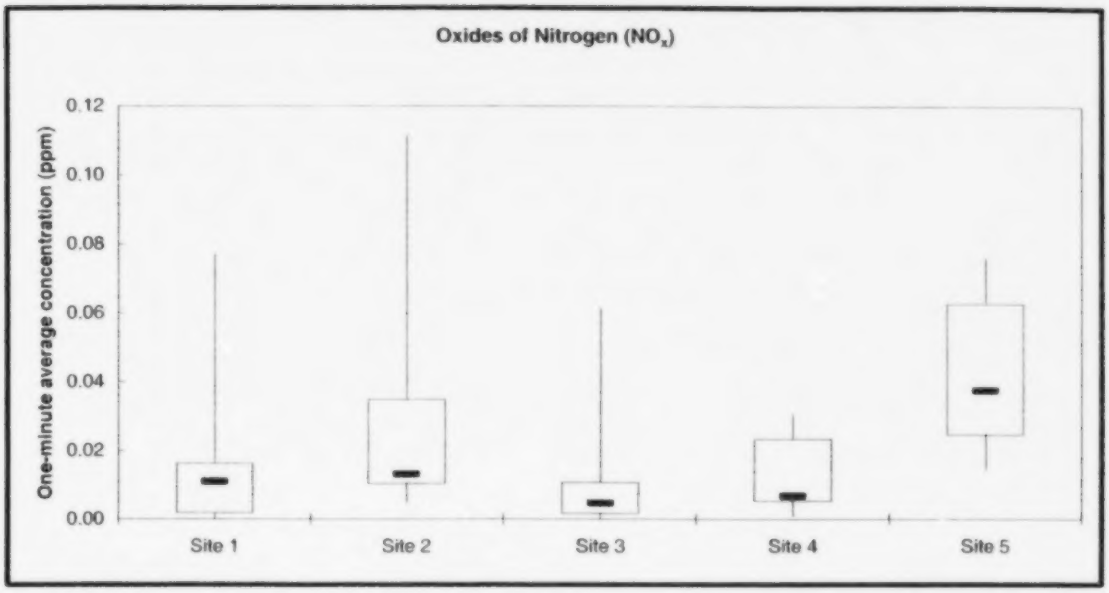


**Figure 8: Oxide of nitrogen concentrations measured by the MAML in the area around Turner valley. Minimum, median, maximum, 25th and 75th percentile are presented. A key for interpreting the graphical presentation is found in Figure 2.**

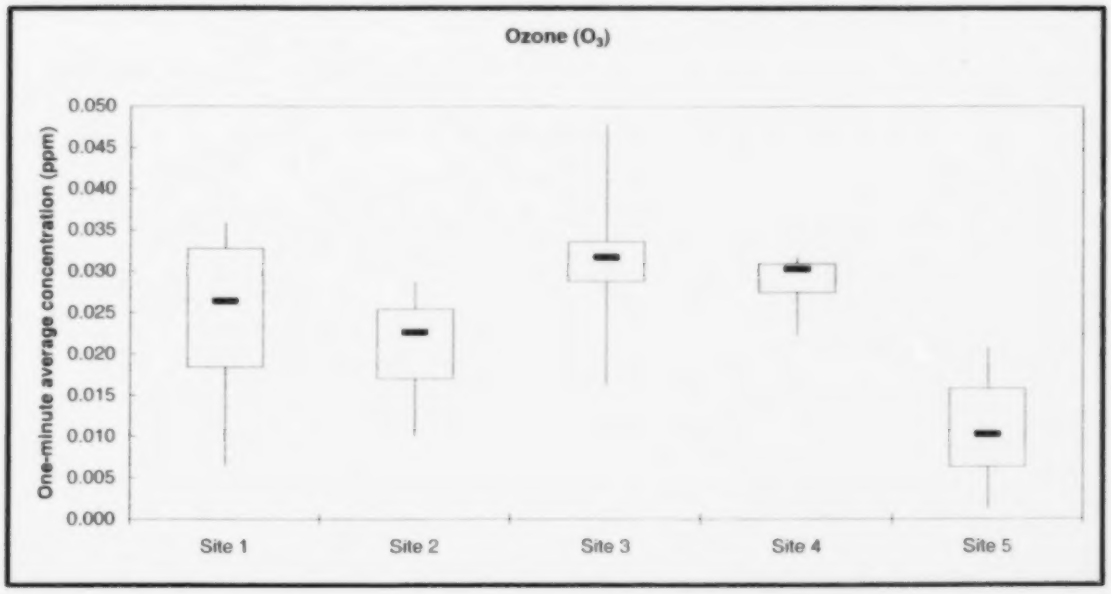


**Figure 9: Ozone concentrations measured by the MAML in the area around Turner valley. Minimum, median, maximum, 25th and 75th percentile are presented. A key for interpreting the graphical presentation is found in Figure 2.**

## *Volatile Organic Compounds (VOCs)*

Vegetation, fossil fuel combustion, fugitive gasoline emissions, petroleum and chemical industries, dry cleaning and fireplaces are major sources of VOCs. Elevated levels of reactive hydrocarbons measured by the MAML downwind of the historical gas plant have already been discussed in the section on total hydrocarbons. Elevated hydrocarbons concentrations are most probably due to fugitive emissions (seepages) from the historical gas plant site. Air samples downwind of the gas plant and ground well also contained significantly higher VOCs concentrations.

To quantify specific hydrocarbons, canister samples of air were collected downwind of the ground flare (**Site 6**) and downwind of the historical plant as whole (**Site 2**). For comparison purposes a background sample was collected 8 km north of the plant (**Site 7**). Canister samples were collected for an hour, thus the values given in Table 2 and in Appendix A are ***one-hour averages***. This allows the comparison of the measured values to Alberta's Ambient Air Quality Objectives (AAAQO) when available. Table 2 also presents VOCs concentration measured south of Red Deer in an area known as Gasoline alley. This area has significant amount of traffic as well as a large number of gasoline stations. Vehicle emissions and fugitive emissions from distribution and storage of gasoline are large sources of atmospheric VOCs.

The highest concentrations of VOCs were measured directly downwind of the ground flare (**Site 6**). This suggests that the ground flare was not 100% efficient in converting the emitted VOCs into $CO_2$ and water vapour. Furthermore, concentrations downwind of the gas plant (**Site 2**) as a whole were also elevated relative to background and the comparison measurement presented in Table 2. Compounds from the alkane family were the most abundant with propane having the highest concentration. There are no AAAQO for the highest VOCs measured. For the VOCs listed in Table 2, AAAQOs are available for acetone and benzene. The AAAQO of 5,900 $\mu g/m^3$ for acetone and 30 $\mu g/m^3$ for benzene, were not exceeded by the concentrations measured at the Turner Valley historical gas plant. Furthermore, none of the Alberta's objectives for VOCs were exceeded. A complete list of the VOCs AAAQO is found in Appendix B.

**Table 2: Summary* of Volatile Organic Compounds measured during the Turner Valley survey, concentrations presented are one-hour averages.**

| | Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|---|
| | Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| | Location | Ground Flare (South side of plant) | Downwind of Plant (East End of Sunset BLVD) | Background (8 km North of Plant) | Red Deer Gasoline alley |
| | Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| Alkanes | Propane | 2759.40 | 943.72 | 1.46 | 25.41 |
| | Butane | 1031.27 | 365.78 | 2.29 | 16.16 |
| | Isobutane | 776.20 | 271.29 | 0.56 | 6.98 |
| | 2-Methylbutane | 549.30 | 162.38 | 0.77 | 5.34 |
| | Pentane | 445.32 | 131.96 | 0.42 | 4.82 |
| | 2-Methylpentane | 155.61 | 37.58 | 0.25 | 1.43 |
| | Hexane | 138.89 | 38.39 | 0.29 | 1.76 |
| | 3-Methylpentane | 90.00 | 19.46 | 0.22 | 0.90 |
| | Heptane | 43.32 | 10.72 | 0.10 | 0.86 |
| | 2-Methylhexane | 28.90 | 6.39 | 0.11 | 0.56 |
| | 3-Methylhexane | 28.01 | 5.91 | 0.11 | 0.68 |
| | 2,3-Dimethylbutane | 23.88 | 5.00 | 0.06 | 1.29 |
| Cycloalkanes | Methylcyclohexane | 69.38 | 11.68 | 0.08 | 0.38 |
| | Cyclohexane | 68.23 | 12.76 | 0.06 | 0.72 |
| | Methylcyclopentane | 64.40 | 12.82 | 0.11 | 0.90 |
| | Cyclopentane | 35.50 | 7.08 | 0.03 | 0.29 |
| Others | Benzene | 20.14 | 5.54 | 0.34 | 0.00 |
| | Methanol | 18.97 | 13.92 | 11.79 | 25.41 |
| | Acetone | 17.57 | 8.97 | 4.47 | 16.16 |
| | Hexanal | 22.07 | 0.80 | 0.46 | 5.98 |

**Notes:**

* The top 20 (by concentration) VOCs measured downwind of the ground flare at the historical gas plant.

**Table 2: Summary* of Volatile Organic Compounds measured during the Turner Valley survey, concentrations presented are one-hour averages.**

| | Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|---|
| | Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| | Location | **Ground Flare** (south side of plant) | **Downwind of Plant** (East End of Sunset BLVD) | **Background** (8 km North of Plant) | **Red Deer Gasoline alley** |
| | Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| Alkanes | Propane | 2759.40 | 943.72 | 1.46 | 25.41 |
| | **Butane** | **1031.27** | **365.78** | **2.29** | **16.16** |
| | Isobutane | 776.20 | 271.29 | 0.56 | 6.98 |
| | **2-Methylbutane** | **549.30** | **162.36** | **0.77** | **5.34** |
| | Pentane | 445.32 | 131.96 | 0.42 | 4.82 |
| | **2-Methylpentane** | **156.61** | **37.58** | **0.25** | **1.43** |
| | Hexane | 138.89 | 38.39 | 0.29 | 1.76 |
| | **3-Methylpentane** | **90.00** | **19.46** | **0.22** | **0.90** |
| | Heptane | 43.32 | 10.72 | 0.10 | 0.86 |
| | **2-Methylhexane** | **28.90** | **6.39** | **0.11** | **0.56** |
| | 3-Methylhexane | 28.01 | 5.91 | 0.11 | 0.68 |
| | **2,3-Dimethylbutane** | **23.88** | **5.00** | **0.06** | **1.29** |
| Cycloalkanes | Methylcyclohexane | 69.38 | 11.68 | 0.08 | 0.38 |
| | **Cyclohexane** | **68.23** | **12.76** | **0.06** | **0.72** |
| | Methylcyclopentane | 64.40 | 12.82 | 0.11 | 0.90 |
| | **Cyclopentane** | **35.50** | **7.08** | **0.03** | **0.29** |
| Others | Benzene | 20.14 | 5.54 | 0.34 | 0.00 |
| | **Methanol** | **18.97** | **13.92** | **11.79** | **25.41** |
| | Acetone | 17.57 | 8.97 | 4.47 | 16.16 |
| | **Hexanal** | **22.07** | **0.80** | **0.46** | **6.98** |

**Notes:**

* The top 20 (by concentration) VOCs measured downwind of the ground flare at the historical gas plant

*Intentionally Blank*

*Appendix A*

**Table 3: One-hour average Volatile Organic Compound Concentrations**

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | Ground Flare (south side of plant) | Downwind of Plant (East End of Sunset BLVD) | Background (8 km North of Plant) | Red Deer Gasoline alley |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| 1,1,1-Trichloroethane | 0.10 | 0.10 | 0.09 | 0.17 |
| 1,1,2,2-Tetrachloroethane | 0.00 | 0.00 | 0.00 | 0.00 |
| 1,1,2-Trichloroethane | 0.00 | 0.00 | 0.00 | 0.00 |
| 1,1-Dichloroethane | 0.00 | 0.00 | 0.00 | 0.02 |
| 1,1-Dichloroethene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***1,2,3-Trimethylbenzene*** | ***0.13*** | ***0.07*** | ***0.02*** | ***0.08*** |
| 1,2,4-Trichlorobenzene | 0.00 | 0.00 | 0.00 | 0.05 |
| ***1,2,4-Trimethylbenzene*** | ***0.58*** | ***0.30*** | ***0.09*** | ***0.27*** |
| 1,2-Dibromoethane ( EDB ) | 0.00 | 0.00 | 0.00 | 0.00 |
| 1,2-Dichlorobenzene | 0.00 | 0.00 | 0.00 | 0.02 |
| ***1,2-Dichloroethane*** | ***0.45*** | ***0.12*** | ***0.03*** | ***0.11*** |
| 1,2-Dichloropropane | 0.00 | 0.00 | 0.00 | 0.00 |
| 1,2-Diethylbenzene | 0.01 | 0.00 | 0.00 | 0.00 |
| ***1,3,5-Trimethylbenzene*** | ***0.21*** | ***0.09*** | ***0.02*** | ***0.06*** |
| ***1,3-Butadiene*** | ***0.20*** | ***0.14*** | ***0.03*** | ***0.11*** |
| 1,3-Dichlorobenzene | 0.00 | 0.00 | 0.00 | 0.02 |
| 1,3-Diethylbenzene | 0.02 | 0.02 | 0.00 | 0.02 |
| 1,4-Dichlorobenzene | 0.02 | 0.02 | 0.01 | 0.44 |
| 1,4-Dichlorobutane | 0.00 | 0.00 | 0.00 | 0.14 |
| 1,4-Diethylbenzene | 0.06 | 0.04 | 0.00 | 0.06 |
| ***1-Butanol (Butyl alcohol)*** | ***0.52*** | ***0.22*** | ***0.35*** | ***0.00*** |
| ***1-Butene/2-Methylpropene*** | ***1.29*** | ***0.49*** | ***0.11*** | ***0.47*** |
| 1-Butyne | 0.01 | 0.01 | 0.00 | 0.00 |
| 1-Decene | 0.00 | 0.00 | 0.00 | 0.00 |
| 1-Heptene | 0.00 | 0.00 | 0.15 | 0.00 |
| 1-Hexene/2-Methyl-1-Pentene | 0.07 | 0.07 | 0.00 | 0.00 |
| 1-Methylcyclohexene | 0.12 | 0.03 | 0.00 | 0.00 |
| 1-Methylcyclopentene | 0.06 | 0.03 | 0.00 | 0.02 |
| ***1-Nonene*** | ***1.04*** | ***0.00*** | ***0.01*** | ***0.08*** |
| 1-Octene | 1.81 | 0.00 | 0.00 | 0.03 |
| ***1-Pentene*** | ***0.21*** | ***0.18*** | ***0.03*** | ***0.12*** |
| 1-Undecene | 0.00 | 0.00 | 0.00 | 0.00 |

Continued ...

**Table 1: One-hour average Volatile Organic Compound concentrations (Continued)**

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | Ground Flare (south side of plant) | Downwind of Plant (East End of Sunset BLVD) | Background (8 km North of Plant) | Red Deer Gasoline alley |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| 2,2,3-Trimethylbutane | 0.69 | 0.13 | 0.00 | 0.02 |
| 2,2,4-Trimethylpentane | 1.95 | 0.58 | 0.12 | 0.45 |
| 2,2,5-Trimethylhexane | 0.17 | 0.04 | 0.01 | 0.03 |
| 2,2-Dimethylbutane | 10.33 | 2.18 | 0.03 | 0.12 |
| 2,2-Dimethylhexane | 0.00 | 0.00 | 0.00 | 0.00 |
| 2,2-Dimethylpentane | 3.21 | 0.56 | 0.01 | 0.05 |
| 2,2-Dimethylpropane | 7.52 | 2.23 | 0.00 | 0.05 |
| 2,3,4-Trimethylpentane | 0.60 | 0.14 | 0.03 | 0.12 |
| 2,3-Dimethylbutane | 23.88 | 5.00 | 0.06 | 0.29 |
| 2,3-Dimethylpentane | 10.79 | 2.18 | 0.11 | 0.54 |
| 2,4-Dimethylhexane | 3.13 | 0.47 | 0.02 | 0.09 |
| 2,4-Dimethylpentane | 8.38 | 1.60 | 0.05 | 0.20 |
| 2,5-Dimethylhexane | 2.36 | 0.35 | 0.01 | 0.09 |
| 2-Butanol | 0.21 | 0.06 | 0.10 | 0.00 |
| 2-Butenal (Crotonaldehdye) | 0.00 | 0.00 | 0.00 | 0.00 |
| 2-Ethyl-1-Butene | 0.00 | 0.00 | 0.00 | 0.00 |
| 2-Ethyltoluene | 0.14 | 0.07 | 0.02 | 0.08 |
| 2-Methyl-1-Butene | 0.14 | 0.14 | 0.02 | 0.06 |
| 2-Methyl-2-Butene | 0.18 | 0.14 | 0.01 | 0.05 |
| 2-Methylbutanal(Isovaleraldehyde) | 0.00 | 0.00 | 0.10 | 0.00 |
| 2-Methylbutane | 549.30 | 162.36 | 0.77 | 5.34 |
| 2-Methylfuran | 0.00 | 0.00 | 0.02 | 0.00 |
| 2-Methylheptane | 11.70 | 1.71 | 0.03 | 0.20 |
| 2-Methylhexane | 28.90 | 6.39 | 0.11 | 0.72 |
| 2-Methylpentane | 156.61 | 37.58 | 0.25 | 1.43 |
| 2-Methyl-Propanal (Isobutylaldehyde) | 0.39 | 0.38 | 0.11 | 0.00 |
| 2-Pentanone | 0.00 | 0.00 | 0.20 | 0.57 |
| 3,6-Dimethyloctane | 0.07 | 0.02 | 0.00 | 0.02 |
| 3-Ethyltoluene | 0.36 | 0.18 | 0.06 | 0.15 |
| 3-Methyl-1-Butene | 0.05 | 0.04 | 0.01 | 0.03 |
| 3-Methyl-1-Pentene | 0.02 | 0.02 | 0.00 | 0.00 |
| 3-Methylheptane | 6.55 | 0.95 | 0.03 | 0.165 |

Continued ...

**Table 3: One-hour average Volatile Organic Compound Concentrations**

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | **Ground Flare** (south side of plant) | **Downwind of Plant** (East End of Sunset BLVD) | **Background** (8 km North of Plant) | **Red Deer Gasoline alley** |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| 1,1,1-Trichloroethane | 0.10 | 0.10 | 0.09 | 0.17 |
| 1,1,2,2-Tetrachloroethane | 0.00 | 0.00 | 0.00 | 0.00 |
| 1,1,2-Trichloroethane | 0.00 | 0.00 | 0.00 | 0.00 |
| 1,1-Dichloroethane | 0.00 | 0.00 | 0.00 | 0.02 |
| 1,1-Dichloroethene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***1,2,3-Trimethylbenzene*** | ***0.13*** | ***0.07*** | ***0.02*** | ***0.08*** |
| 1,2,4-Trichlorobenzene | 0.00 | 0.00 | 0.00 | 0.05 |
| ***1,2,4-Trimethylbenzene*** | ***0.58*** | ***0.30*** | ***0.09*** | ***0.27*** |
| 1,2-Dibromoethane ( EDB ) | 0.00 | 0.00 | 0.00 | 0.00 |
| 1,2-Dichlorobenzene | 0.00 | 0.00 | 0.00 | 0.02 |
| ***1,2-Dichloroethane*** | ***0.45*** | ***0.12*** | ***0.03*** | ***0.11*** |
| 1,2-Dichloropropane | 0.00 | 0.00 | 0.01 | 0.00 |
| 1,2-Diethylbenzene | 0.01 | 0.00 | 0.00 | 0.00 |
| ***1,3,5-Trimethylbenzene*** | ***0.21*** | ***0.09*** | ***0.02*** | ***0.06*** |
| ***1,3-Butadiene*** | ***0.20*** | ***0.14*** | ***0.03*** | ***0.11*** |
| 1,3-Dichlorobenzene | 0.00 | 0.00 | 0.00 | 0.02 |
| 1,3-Diethylbenzene | 0.02 | 0.02 | 0.00 | 0.02 |
| 1,4-Dichlorobenzene | 0.02 | 0.02 | 0.01 | 0.44 |
| 1,4-Dichlorobutane | 0.00 | 0.00 | 0.00 | 0.14 |
| 1,4-Diethylbenzene | 0.06 | 0.04 | 0.00 | 0.06 |
| ***1-Butanol (Butyl alcohol)*** | ***0.52*** | ***0.22*** | ***0.35*** | ***0.00*** |
| ***1-Butene/2-Methylpropene*** | ***1.29*** | ***0.49*** | ***0.11*** | ***0.47*** |
| 1-Butyne | 0.01 | 0.01 | 0.00 | 0.00 |
| 1-Decene | 0.00 | 0.00 | 0.00 | 0.00 |
| 1-Heptene | 0.00 | 0.00 | 0.15 | 0.00 |
| 1-Hexene/2-Methyl-1-Pentene | 0.07 | 0.07 | 0.00 | 0.00 |
| 1-Methylcyclohexene | 0.12 | 0.03 | 0.00 | 0.00 |
| 1-Methylcyclopentene | 0.06 | 0.03 | 0.00 | 0.02 |
| ***1-Nonene*** | ***1.04*** | ***0.00*** | ***0.01*** | ***0.08*** |
| 1-Octene | 1.81 | 0.00 | 0.00 | 0.03 |
| ***1-Pentene*** | ***0.21*** | ***0.18*** | ***0.03*** | ***0.12*** |
| 1-Undecene | 0.00 | 0.00 | 0.00 | 0.00 |

Continued ...

**Table 1: One-hour average Volatile Organic Compound concentrations (Continued)**

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | **Ground Flare** (south side of plant) | **Downwind of Plant** (East End of Sunset BLVD) | **Background** (8 km North of Plant) | **Red Deer Gasoline alley** |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| ***2,2,3-Trimethylbutane*** | ***0.69*** | ***0.13*** | ***0.00*** | ***0.02*** |
| ***2,2,4-Trimethylpentane*** | ***1.95*** | ***0.58*** | ***0.12*** | ***0.45*** |
| ***2,2,5-Trimethylhexane*** | ***0.17*** | ***0.04*** | ***0.01*** | ***0.03*** |
| ***2,2-Dimethylbutane*** | ***10.33*** | ***2.18*** | ***0.03*** | ***0.12*** |
| 2,2-Dimethylhexane | 0.00 | 0.00 | 0.00 | 0.00 |
| ***2,2-Dimethylpentane*** | ***3.21*** | ***0.56*** | ***0.01*** | ***0.05*** |
| 2,2-Dimethylpropane | 7.52 | 2.23 | 0.00 | 0.05 |
| ***2,3,4-Trimethylpentane*** | ***0.60*** | ***0.14*** | ***0.03*** | ***0.12*** |
| ***2,3-Dimethylbutane*** | ***23.88*** | ***5.00*** | ***0.06*** | ***0.29*** |
| ***2,3-Dimethylpentane*** | ***10.79*** | ***2.18*** | ***0.11*** | ***0.54*** |
| ***2,4-Dimethylhexane*** | ***3.13*** | ***0.47*** | ***0.02*** | ***0.09*** |
| ***2,4-Dimethylpentane*** | ***8.38*** | ***1.60*** | ***0.05*** | ***0.20*** |
| ***2,5-Dimethylhexane*** | ***2.36*** | ***0.35*** | ***0.01*** | ***0.09*** |
| ***2-Butanol*** | ***0.21*** | ***0.06*** | ***0.10*** | ***0.00*** |
| 2-Butenal (Crotonaldehdye) | 0.00 | 0.00 | 0.00 | 0.00 |
| 2-Ethyl-1-Butene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***2-Ethyltoluene*** | ***0.14*** | ***0.07*** | ***0.02*** | ***0.08*** |
| ***2-Methyl-1-Butene*** | ***0.14*** | ***0.14*** | ***0.02*** | ***0.06*** |
| ***2-Methyl-2-Butene*** | ***0.18*** | ***0.14*** | ***0.01*** | ***0.05*** |
| 2-Methylbutanal(Isovaleraldehyde) | 0.00 | 0.00 | 0.10 | 0.00 |
| ***2-Methylbutane*** | ***549.30*** | ***162.36*** | ***0.77*** | ***5.34*** |
| 2-Methylfuran | 0.00 | 0.00 | 0.02 | 0.00 |
| ***2-Methylheptane*** | ***11.70*** | ***1.71*** | ***0.03*** | ***0.20*** |
| ***2-Methylhexane*** | ***28.90*** | ***6.39*** | ***0.11*** | ***0.72*** |
| ***2-Methylpentane*** | ***156.61*** | ***37.58*** | ***0.25*** | ***1.43*** |
| ***2-Methyl-Propanal (Isobutylaldehyde)*** | ***0.39*** | ***0.38*** | ***0.11*** | ***0.00*** |
| 2-Pentanone | 0.00 | 0.00 | 0.20 | 0.57 |
| ***3,6-Dimethyloctane*** | ***0.07*** | ***0.02*** | ***0.00*** | ***0.02*** |
| ***3-Ethyltoluene*** | ***0.36*** | ***0.18*** | ***0.06*** | ***0.15*** |
| ***3-Methyl-1-Butene*** | ***0.05*** | ***0.04*** | ***0.01*** | ***0.03*** |
| 3-Methyl-1-Pentene | 0.02 | 0.02 | 0.00 | 0.00 |
| ***3-Methylheptane*** | ***6.55*** | ***0.95*** | ***0.03*** | ***0.165*** |

Continued ...

**Table 1: One-hour average Volatile Organic Compound concentrations (Continued)**

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | Ground Flare (south side of plant) | Downwind of Plant (East End of Sunset BLVD) | Background (8 km North of Plant) | Red Deer Gasoline alley |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| ***3-Methylhexane*** | ***28.01*** | ***5.91*** | ***0.11*** | ***0.90*** |
| ***3-Methylpentane*** | ***90.00*** | ***19.46*** | ***0.22*** | ***0.90*** |
| ***4-Ethyltoluene*** | ***0.18*** | ***0.09*** | ***0.03*** | ***0.09*** |
| 4-Methyl-1-Pentene | 0.00 | 0.02 | 0.00 | 0.00 |
| 4-Methylheptane | 2.68 | 0.44 | 0.00 | 0.06 |
| Acetaldehyde | 12.80 | 6.52 | 16.89 | 7.45 |
| ***Acetone*** | ***17.57*** | ***8.97*** | ***4.47*** | ***8.04*** |
| Acetonitrile | 0.23 | 0.44 | 0.54 | 0.00 |
| ***Acrolein (2-Propenal)*** | ***0.64*** | ***0.66*** | ***0.38*** | ***0.00*** |
| Acrylonitrile (2-Propennitrile) | 0.00 | 0.00 | 0.00 | 0.00 |
| ***a-Pinene*** | ***0.18*** | ***0.21*** | ***0.02*** | ***0.02*** |
| Benzaldehyde | 0.30 | 0.09 | 0.44 | 0.04 |
| ***Benzene*** | ***20.14*** | ***5.54*** | ***0.34*** | ***1.65*** |
| Benzyl Chloride | 0.00 | 0.00 | 0.00 | 0.00 |
| ***b-Pinene*** | ***0.09*** | ***0.07*** | ***0.02*** | ***0.00*** |
| Bromodichloromethane | 0.00 | 0.00 | 0.01 | 0.00 |
| Bromoform | 0.00 | 0.01 | 0.01 | 0.05 |
| Bromomethane | 0.06 | 0.06 | 0.05 | 0.06 |
| Bromotrichloromethane | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Butane*** | ***1031.27*** | ***365.78*** | ***2.29*** | ***16.16*** |
| Butylacetate | 0.00 | 0.05 | 0.03 | 0.00 |
| Butylaldehyde (Butanal) | 0.00 | 0.60 | 0.57 | 0.00 |
| c-1,2-Dichloroethene | 0.00 | 0.00 | 0.00 | 0.00 |
| c-1,2-Dimethylcyclohexane | 0.52 | 0.08 | 0.00 | 0.00 |
| c-1,3-Dichloropropene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***c-1,3-Dimethylcyclohexane*** | ***8.97*** | ***1.46*** | ***0.02*** | ***0.09*** |
| ***c-1,4/t-1,3-Dimethylcyclohexane*** | ***1.11*** | ***0.14*** | ***0.01*** | ***0.03*** |
| ***c-2-Butene*** | ***0.21*** | ***0.11*** | ***0.01*** | ***0.05*** |
| c-2-Heptene | 0.01 | 0.00 | 0.01 | 0.03 |
| c-2-Hexene | 0.03 | 0.02 | 0.00 | 0.00 |
| ***c-2-Pentene*** | ***0.08*** | ***0.06*** | ***0.01*** | ***0.03*** |
| c-3-Heptene | 0.00 | 0.00 | 0.00 | 0.20 |

Continued ...

**Table 1: One-hour average Volatile Organic Compound concentrations (Continued)**

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | Ground Flare (south side of plant) | Downwind of Plant (East End of Sunset BLVD) | Background (8 km North of Plant) | Red Deer Gasoline alley |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| c-3-Methyl-2-Pentene | 0.05 | 0.03 | 0.00 | 0.00 |
| c-4-Methyl-2-Pentene | 0.00 | 0.00 | 0.00 | 0.02 |
| Camphene | 0.00 | 0.06 | 0.01 | 0.02 |
| ***Carbon Disulfide*** | ***0.25*** | ***0.19*** | ***0.15*** | ***0.17*** |
| Carbontretrachloride | 0.56 | 0.58 | 0.59 | 0.63 |
| ***Chlorobenzene*** | ***0.92*** | ***0.12*** | ***0.00*** | ***0.02*** |
| Chloroethane | 0.00 | 0.00 | 0.01 | 0.00 |
| Chloroform | 0.06 | 0.06 | 0.06 | 0.26 |
| Chloromethane | 1.12 | 1.08 | 1.05 | 1.28 |
| ***Cyclohexane*** | ***68.23*** | ***12.75*** | ***0.00*** | ***0.56*** |
| Cyclohexanone | 0.00 | 0.00 | 0.05 | 0.63 |
| Cyclohexene | 0.15 | 0.04 | 0.00 | 0.00 |
| ***Cyclopentane*** | ***35.50*** | ***7.08*** | ***0.03*** | ***0.38*** |
| Cyclopentanone | 0.00 | 0.00 | 0.06 | 0.00 |
| ***Cyclopentene*** | ***0.06*** | ***0.02*** | ***0.00*** | ***0.02*** |
| ***Decane*** | ***0.65*** | ***0.15*** | ***0.02*** | ***0.32*** |
| Dibromochloromethane | 0.00 | 0.00 | 0.00 | 0.02 |
| Dibromomethane | 0.04 | 0.05 | 0.03 | 0.14 |
| ***Dichloromethane*** | ***0.49*** | ***0.67*** | ***0.22*** | ***5.07*** |
| ***Dodecane*** | ***0.10*** | ***0.09*** | ***0.02*** | ***0.21*** |
| Ethanol | 4.05 | 7.94 | 3.32 | 9.42 |
| Ethylacetate | 0.00 | 0.53 | 0.02 | 0.00 |
| ***Ethylbenzene*** | ***1.17*** | ***0.46*** | ***0.11*** | ***0.48*** |
| Ethylbromide | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Ethylene oxide*** | ***6.24*** | ***0.00*** | ***0.07*** | ***0.00*** |
| Freon 11 (Trichlorofluoromethane) | 1.66 | 1.65 | 1.63 | 1.40 |
| Freon 113 (1,1,2-Trichlorotrifluoroethane | 0.66 | 0.68 | 0.66 | 0.48 |
| Freon 114 (1,2-Dichlorotetrafluoroethane | 0.15 | 0.14 | 0.12 | 0.18 |
| Freon 12 (Dichlorodifluoromethane) | 3.08 | 2.96 | 2.74 | 2.45 |
| Freon 22 (Chlorodifluoromethane) | 0.69 | 0.67 | 0.55 | 0.54 |
| ***Heptane*** | ***43.32*** | ***10.72*** | ***0.10*** | ***1.29*** |
| Hexachlorobutadiene | 0.00 | 0.00 | 0.00 | 0.00 |

Continued ...

Table 1: One-hour average Volatile Organic Compound concentrations (Continued)

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | **Ground Flare** (south side of plant) | **Downwind of Plant** (East End of Sunset BLVD) | **Background** (8 km North of Plant) | **Red Deer Gasoline alley** |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| ***3-Methylhexane*** | ***28.01*** | ***5.91*** | ***0.11*** | ***0.90*** |
| ***3-Methylpentane*** | ***90.00*** | ***19.46*** | ***0.22*** | ***0.90*** |
| ***4-Ethyltoluene*** | ***0.18*** | ***0.09*** | ***0.03*** | ***0.09*** |
| 4-Methyl-1-Pentene | 0.00 | 0.02 | 0.00 | 0.00 |
| 4-Methylheptane | 2.68 | 0.44 | 0.00 | 0.06 |
| Acetaldehyde | 12.80 | 6.62 | 16.89 | 7.05 |
| ***Acetone*** | ***17.57*** | ***8.97*** | ***4.47*** | ***8.04*** |
| Acetonitrile | 0.23 | 0.44 | 0.54 | 0.00 |
| ***Acrolein (2-Propenal)*** | ***0.64*** | ***0.66*** | ***0.38*** | ***0.00*** |
| Acrylonitrile (2-Propennitrile) | 0.00 | 0.00 | 0.00 | 0.00 |
| ***a-Pinene*** | ***0.18*** | ***0.21*** | ***0.02*** | ***0.02*** |
| Benzaldehyde | 0.30 | 0.29 | 0.44 | 0.54 |
| ***Benzene*** | ***20.14*** | ***5.54*** | ***0.34*** | ***1.65*** |
| Benzyl Chloride | 0.00 | 0.00 | 0.00 | 0.00 |
| ***b-Pinene*** | ***0.09*** | ***0.07*** | ***0.02*** | ***0.00*** |
| Bromodichloromethane | 0.00 | 0.00 | 0.01 | 0.06 |
| Bromoform | 0.00 | 0.01 | 0.01 | 0.05 |
| Bromomethane | 0.06 | 0.06 | 0.05 | 0.06 |
| Bromotrichloromethane | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Butane*** | ***1031.27*** | ***365.78*** | ***2.29*** | ***16.16*** |
| Butylacetate | 0.00 | 0.05 | 0.03 | 0.00 |
| Butylaldehyde (Butanal) | 0.00 | 0.60 | 0.57 | 0.00 |
| c-1,2-Dichloroethene | 0.00 | 0.00 | 0.00 | 0.00 |
| c-1,2-Dimethylcyclohexane | 0.52 | 0.08 | 0.00 | 0.00 |
| c-1,3-Dichloropropene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***c-1,3-Dimethylcyclohexane*** | ***8.97*** | ***1.46*** | ***0.02*** | ***0.09*** |
| ***c-1,4/t-1,3-Dimethylcyclohexane*** | ***1.11*** | ***0.14*** | ***0.01*** | ***0.03*** |
| ***c-2-Butene*** | ***0.21*** | ***0.11*** | ***0.01*** | ***0.05*** |
| c-2-Heptene | 0.01 | 0.00 | 0.01 | 0.03 |
| c-2-Hexene | 0.03 | 0.02 | 0.00 | 0.00 |
| ***c-2-Pentene*** | ***0.08*** | ***0.06*** | ***0.01*** | ***0.03*** |
| c-3-Heptene | 0.00 | 0.00 | 0.00 | 0.20 |

Continued ...

Table 1: One-hour average Volatile Organic Compound concentrations (Continued)

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | **Ground Flare** (south side of plant) | **Downwind of Plant** (East End of Sunset BLVD) | **Background** (8 km North of Plant) | **Red Deer Gasoline alley** |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| c-3-Methyl-2-Pentene | 0.05 | 0.03 | 0.00 | 0.00 |
| c-4-Methyl-2-Pentene | 0.00 | 0.00 | 0.00 | 0.02 |
| Camphene | 0.00 | 0.06 | 0.01 | 0.02 |
| ***Carbon Disulfide*** | ***0.25*** | ***0.19*** | ***0.15*** | ***0.17*** |
| Carbontretrachloride | 0.56 | 0.58 | 0.59 | 0.63 |
| ***Chlorobenzene*** | ***0.92*** | ***0.12*** | ***0.00*** | ***0.02*** |
| Chloroethane | 0.00 | 0.00 | 0.01 | 0.00 |
| Chloroform | 0.06 | 0.06 | 0.06 | 0.26 |
| Chloromethane | 1.12 | 1.08 | 1.05 | 1.28 |
| ***Cyclohexane*** | ***68.23*** | ***12.76*** | ***0.06*** | ***0.56*** |
| Cyclohexanone | 0.00 | 0.00 | 0.05 | 0.63 |
| Cyclohexene | 0.15 | 0.04 | 0.00 | 0.00 |
| ***Cyclopentane*** | ***35.50*** | ***7.08*** | ***0.03*** | ***0.38*** |
| Cyclopentanone | 0.00 | 0.00 | 0.06 | 0.00 |
| ***Cyclopentene*** | ***0.06*** | ***0.02*** | ***0.00*** | ***0.02*** |
| ***Decane*** | ***0.66*** | ***0.15*** | ***0.02*** | ***0.32*** |
| Dibromochloromethane | 0.00 | 0.00 | 0.00 | 0.02 |
| Dibromomethane | 0.04 | 0.05 | 0.03 | 0.14 |
| ***Dichloromethane*** | ***0.49*** | ***0.67*** | ***0.22*** | ***5.07*** |
| ***Dodecane*** | ***0.10*** | ***0.09*** | ***0.02*** | ***0.21*** |
| Ethanol | 4.05 | 7.94 | 3.32 | 9.42 |
| Ethylacetate | 0.00 | 0.53 | 0.02 | 0.00 |
| ***Ethylbenzene*** | ***1.17*** | ***0.46*** | ***0.11*** | ***0.48*** |
| Ethylbromide | 0.00 | 0.00 | 0.00 | 0.00 |
| ***Ethylene oxide*** | ***6.24*** | ***0.00*** | ***0.07*** | ***0.00*** |
| Freon 11 (Trichlorofluoromethane) | 1.66 | 1.65 | 1.63 | 1.40 |
| Freon 113 (1,1,2-Trichlorotrifluoroethane | 0.66 | 0.68 | 0.66 | 0.48 |
| Freon 114 (1,2-Dichlorotetrafluoroethane | 0.15 | 0.14 | 0.12 | 0.18 |
| Freon 12 (Dichlorodifluoromethane) | 3.08 | 2.96 | 2.74 | 2.45 |
| Freon 22 (Chlorodifluoromethane) | 0.69 | 0.67 | 0.55 | 0.54 |
| ***Heptane*** | ***43.32*** | ***10.72*** | ***0.10*** | ***1.29*** |
| Hexachlorobutadiene | 0.00 | 0.00 | 0.00 | 0.00 |

Continued ...

**Table 1: One-hour average Volatile Organic Compound concentrations (Continued)**

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | Ground Flare (south side of plant) | Downwind of Plant (East End of Sunset BLVD) | Background (6 km North of Plant) | Red Deer Gasoline alley |
| Units | ug/m3 | ug/m3 | ug/m3 | ug/m3 |
| ***Hexanal*** | ***22.07*** | ***0.80*** | ***0.49*** | ***0.00*** |
| ***Hexane*** | ***138.89*** | ***38.39*** | ***0.29*** | ***1.76*** |
| Hexylbenzene | 0.00 | 0.00 | 0.00 | 0.02 |
| Indan (2,3-Dihydroindene) | 0.04 | 0.03 | 0.01 | 0.03 |
| ***Isobutane (2-Methylpropane)*** | ***776.20*** | ***271.29*** | ***0.58*** | ***6.92*** |
| Isobutylacetate | 0.00 | 0.00 | 0.00 | 0.00 |
| Isobutylalcohol | 0.00 | 0.00 | 0.02 | 0.00 |
| iso-Butylbenzene | 0.02 | 0.00 | 0.00 | 0.00 |
| ***Isoprene (2-Methyl-1,3-Butadiene)*** | ***0.93*** | ***0.22*** | ***0.04*** | ***0.02*** |
| ***Isopropyl Alcohol*** | ***0.38*** | ***1.10*** | ***0.16*** | ***0.00*** |
| Isopropylacetate | 0.00 | 0.00 | 0.00 | 0.00 |
| ***iso-Propylbenzene*** | ***0.14*** | ***0.03*** | ***0.01*** | ***0.03*** |
| ***Limonene*** | ***0.06*** | ***0.13*** | ***0.01*** | ***0.00*** |
| ***m,p-Xylene*** | ***4.45*** | ***1.72*** | ***0.32*** | ***1.41*** |
| MAC (2-Methyl-2-propenal) | 0.00 | 0.19 | 0.11 | 0.00 |
| ***MEK*** | ***3.21*** | ***2.29*** | ***1.03*** | ***0.00*** |
| ***Methanol*** | ***18.97*** | ***13.92*** | ***11.79*** | ***38.72*** |
| Methyl Acetate | 0.00 | 0.00 | 0.06 | 0.00 |
| ***Methylcyclohexane*** | ***69.38*** | ***11.69*** | ***0.06*** | ***0.00*** |
| ***Methylcyclopentane*** | ***64.40*** | ***12.82*** | ***0.11*** | ***0.68*** |
| Methyl-t-Butyl Ether ( MTBE) | 0.00 | 0.00 | 0.00 | 0.00 |
| MIBK | 0.00 | 0.00 | 0.03 | 0.00 |
| MVK | 0.00 | 0.00 | 0.09 | 0.00 |
| Naphthalene | 0.06 | 0.08 | 0.06 | 0.18 |
| n-Butylbenzene | 0.02 | 0.01 | 0.00 | 0.00 |
| ***Nonane*** | ***4.36*** | ***0.42*** | ***0.03*** | ***0.27*** |
| ***n-Propylbenzene*** | ***0.18*** | ***0.06*** | ***0.02*** | ***0.01*** |
| ***Octane*** | ***12.38*** | ***2.04*** | ***0.04*** | ***0.39*** |
| ***o-Xylene*** | ***0.74*** | ***0.47*** | ***0.13*** | ***0.62*** |
| p-Cymene (1-Methyl-4-Isopropylbenzene) | 0.04 | 0.04 | 0.01 | 0.03 |
| Pentanal | 0.00 | 0.00 | 0.25 | 0.00 |
| ***Pentane*** | ***445.32*** | ***131.96*** | ***0.42*** | ***4.82*** |

Continued ...

**Table 1: One-hour average Volatile Organic Compound concentrations (Continued)**

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | Ground Flare (south side of plant) | Downwind of Plant (East End of Sunset BLVD) | Background (8 km North of Plant) | Red Deer Gasoline alley |
| | ppb | ppb | ppb | ppb |
| ***Propane*** | ***2759.40*** | ***943.72*** | ***1.46*** | ***25.41*** |
| ***Propene*** | ***5.12*** | ***1.06*** | ***0.24*** | ***0.65*** |
| ***Propionaldehyde*** | ***8.07*** | ***4.07*** | ***1.73*** | ***0.00*** |
| ***Propyl alcohol (1-Propanol)*** | ***0.62*** | ***0.12*** | ***0.51*** | ***0.00*** |
| ***Propyne*** | ***0.16*** | ***0.10*** | ***0.03*** | ***0.09*** |
| ***sec-Butylbenzene*** | ***0.00*** | ***0.01*** | ***0.00*** | ***0.02*** |
| Styrene | 0.08 | 0.08 | 0.17 | 0.06 |
| ***t-1,2-Dichloroethene*** | ***0.00*** | ***0.00*** | ***0.00*** | ***0.00*** |
| ***t-1,2-Dimethylcyclohexane*** | ***6.57*** | ***0.89*** | ***0.01*** | ***0.08*** |
| ***t-1,3-Dichloropropene*** | ***0.00*** | ***0.00*** | ***0.00*** | ***0.00*** |
| ***t-1,4-Dimethylcyclohexane*** | ***4.33*** | ***0.57*** | ***0.01*** | ***0.05*** |
| ***t-2-Butene*** | ***0.00*** | ***0.00*** | ***0.01*** | ***0.05*** |
| t-2-Heptene | 0.04 | 0.02 | 0.00 | 0.00 |
| ***t-2-Hexene*** | ***0.11*** | ***0.04*** | ***0.00*** | ***0.02*** |
| t-2-Octene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***t-2-Pentene*** | ***0.25*** | ***0.13*** | ***0.01*** | ***0.05*** |
| t-3-Heptene | 0.03 | 0.01 | 0.00 | 0.00 |
| ***t-3-Methyl-2-Pentene*** | ***0.00*** | ***0.01*** | ***0.00*** | ***0.00*** |
| t-4-Methyl-2-Pentene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***tert-Butylbenzene*** | ***0.00*** | ***0.00*** | ***0.00*** | ***0.00*** |
| Tetrachloroethene | 0.04 | 0.04 | 0.03 | 0.36 |
| ***Toluene*** | ***5.13*** | ***5.73*** | ***0.66*** | ***5.27*** |
| Trichloroethene | 0.04 | 0.04 | 0.02 | 0.39 |
| ***Undecane*** | ***0.22*** | ***0.14*** | ***0.02*** | ***0.24*** |
| Vinylchloride (Chloroethene) | 0.00 | 0.00 | 0.00 | 0.00 |

**Notes :**

***Bold and Italics*** indicates concentrations at Site 6 were elevated with respect to background concentrations.

Table 1: One-hour average Volatile Organic Compound concentrations (Continued)

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | **Ground Flare** (south side of plant) | **Downwind of Plant** (East End of Sunset BLVD) | **Background** (8 km North of Plant) | **Red Deer Gasoline alley** |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| ***Hexanal*** | ***22.07*** | ***0.80*** | ***0.46*** | ***0.00*** |
| ***Hexane*** | ***138.89*** | ***38.39*** | ***0.29*** | ***1.76*** |
| Hexylbenzene | 0.00 | 0.00 | 0.00 | 0.02 |
| Indan (2,3-Dihydroindene) | 0.04 | 0.03 | 0.01 | 0.03 |
| ***Isobutane (2-Methylpropane)*** | ***776.20*** | ***271.29*** | ***0.56*** | ***6.98*** |
| Isobutylacetate | 0.00 | 0.00 | 0.00 | 0.00 |
| Isobutylalcohol | 0.00 | 0.00 | 0.02 | 0.00 |
| iso-Butylbenzene | 0.02 | 0.00 | 0.00 | 0.00 |
| ***Isoprene (2-Methyl-1,3-Butadiene)*** | ***0.93*** | ***0.22*** | ***0.04*** | ***0.03*** |
| ***Isopropyl Alcohol*** | ***0.38*** | ***1.10*** | ***0.16*** | ***0.00*** |
| Isopropylacetate | 0.00 | 0.00 | 0.00 | 0.00 |
| ***iso-Propylbenzene*** | ***0.14*** | ***0.03*** | ***0.01*** | ***0.03*** |
| ***Limonene*** | ***0.06*** | ***0.13*** | ***0.01*** | ***0.05*** |
| ***m,p-Xylene*** | ***4.45*** | ***1.72*** | ***0.32*** | ***1.41*** |
| MAC (2-Methyl-2-propenal) | 0.00 | 0.10 | 0.11 | 0.00 |
| ***MEK*** | ***3.21*** | ***2.29*** | ***1.03*** | ***0.00*** |
| ***Methanol*** | ***18.97*** | ***13.92*** | ***11.79*** | ***38.72*** |
| Methyl Acetate | 0.00 | 0.00 | 0.06 | 0.00 |
| ***Methylcyclohexane*** | ***69.38*** | ***11.68*** | ***0.08*** | ***0.86*** |
| ***Methylcyclopentane*** | ***64.40*** | ***12.82*** | ***0.11*** | ***0.68*** |
| Methyl-t-Butyl Ether ( MTBE ) | 0.00 | 0.00 | 0.00 | 0.00 |
| MIBK | 0.00 | 0.00 | 0.03 | 0.00 |
| MVK | 0.00 | 0.00 | 0.09 | 0.00 |
| Naphthalene | 0.06 | 0.08 | 0.06 | 0.18 |
| n-Butylbenzene | 0.02 | 0.01 | 0.00 | 0.03 |
| ***Nonane*** | ***4.36*** | ***0.42*** | ***0.03*** | ***0.27*** |
| ***n-Propylbenzene*** | ***0.18*** | ***0.06*** | ***0.02*** | ***0.08*** |
| ***Octane*** | ***12.38*** | ***2.04*** | ***0.04*** | ***0.39*** |
| ***o-Xylene*** | ***0.74*** | ***0.47*** | ***0.13*** | ***0.62*** |
| p-Cymene (1-Methyl-4-isopropylbenzene) | 0.04 | 0.04 | 0.01 | 0.03 |
| Pentanal | 0.00 | 0.00 | 0.25 | 0.00 |
| ***Pentane*** | ***445.32*** | ***131.96*** | ***0.42*** | ***4.82*** |

Continued ...

**Table 1: One-hour average Volatile Organic Compound concentrations (Continued)**

| Site | 6 | 2 | 7 | Comparison |
|---|---|---|---|---|
| Sample Date | 24-Nov-05 | 24-Nov-05 | 24-Nov-05 | 15-Feb-05 |
| Location | **Ground Flare** (south side of plant) | **Downwind of Plant** (East End of Sunset BLVD) | **Background** (8 km North of Plant) | **Red Deer Gasoline alley** |
| Units | µg/m³ | µg/m³ | µg/m³ | µg/m³ |
| ***Propane*** | ***2759.40*** | ***943.72*** | ***1.46*** | ***25.41*** |
| ***Propene*** | ***5.12*** | ***1.06*** | ***0.24*** | ***0.65*** |
| ***Propionaldehyde*** | ***8.07*** | ***4.07*** | ***1.73*** | ***0.00*** |
| Propyl alcohol (1-Propanol) | 0.62 | 0.12 | 0.51 | 0.00 |
| ***Propyne*** | ***0.16*** | ***0.10*** | ***0.03*** | ***0.09*** |
| sec-Butylbenzene | 0.03 | 0.01 | 0.00 | 0.02 |
| Styrene | 0.08 | 0.08 | 0.17 | 0.06 |
| t-1,2-Dichloroethene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***t-1,2-Dimethylcyclohexane*** | ***6.57*** | ***0.89*** | ***0.01*** | ***0.08*** |
| t-1,3-Dichloropropene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***t-1,4-Dimethylcyclohexane*** | ***4.33*** | ***0.57*** | ***0.01*** | ***0.05*** |
| t-2-Butene | 0.00 | 0.00 | 0.01 | 0.05 |
| t-2-Heptene | 0.04 | 0.02 | 0.00 | 0.00 |
| ***t-2-Hexene*** | ***0.11*** | ***0.04*** | ***0.00*** | ***0.02*** |
| t-2-Octene | 0.00 | 0.00 | 0.00 | 0.00 |
| ***t-2-Pentene*** | ***0.25*** | ***0.13*** | ***0.01*** | ***0.05*** |
| t-3-Heptene | 0.03 | 0.01 | 0.00 | 0.00 |
| t-3-Methyl-2-Pentene | 0.00 | 0.01 | 0.00 | 0.00 |
| t-4-Methyl-2-Pentene | 0.00 | 0.00 | 0.00 | 0.00 |
| tert-Butylbenzene | 0.00 | 0.00 | 0.00 | 0.00 |
| Tetrachloroethene | 0.04 | 0.04 | 0.03 | 0.36 |
| ***Toluene*** | ***5.13*** | ***5.73*** | ***0.66*** | ***5.27*** |
| Trichloroethene | 0.04 | 0.04 | 0.02 | 0.39 |
| ***Undecane*** | ***0.22*** | ***0.14*** | ***0.02*** | ***0.24*** |
| Vinylchloride (Chloroethene) | 0.00 | 0.00 | 0.00 | 0.00 |

**Notes :**

***Bold and Italics*** indicates concentrations at Site 6 were elevated with respect to background concentrations.

**Table A2: Median one-minute average concentrations for monitoring sites in Turner Valley**

| Monitoring Location | CO PPM | $O_3$ PPM | THC PPM | $CH_4$ PPM | RHC PPM | PAH ng/m$^3$ | $SO_2$ PPM | NO PPM | $NO_2$ PPM | NOx PPM | $NH_3$ PPM | TRS PPM | H2S PPM | TSP (µg/m$^3$) | $PM_{10}$ (µg/m$^3$) | $PM_{2.5}$ (µg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1 | 0.026 | 1.8 | 1.8 | bd | 6 | 0.001 | 0.002 | 0.008 | 0.011 | bd | bd | bd | 120 | 86 | 10 |
| 2 | 0.2 | 0.023 | 10.4 | 7.2 | 2.7 | 5 | 0.002 | 0.003 | 0.010 | 0.013 | bd | bd | bd | 255 | 169 | 21 |
| 3 | bd | 0.032 | 1.7 | 1.7 | bd | 1 | bd | 0.002 | 0.003 | 0.005 | bd | bd | bd | 45 | 37 | 5 |
| 4 | 0.3 | 0.030 | 1.7 | 1.8 | bd | 1 | bd | 0.006 | 0.004 | 0.007 | 0.001 | bd | bd | 145 | 107 | 17 |
| 5 | 0.3 | 0.010 | 1.9 | 1.9 | bd | 16 | bd | 0.047 | 0.005 | 0.037 | 0.003 | bd | bd | 175 | 124 | 21 |

**Table A3: Maximum one-minute average concentrations for monitoring sites in Turner Valley**

| Monitoring Location | CO PPM | $O_3$ PPM | THC PPM | $CH_4$ PPM | RHC PPM | PAH ng/m$^3$ | $SO_2$ PPM | NO PPM | $NO_2$ PPM | NOx PPM | $NH_3$ PPM | TRS PPM | H2S PPM | TSP (µg/m$^3$) | $PM_{10}$ (µg/m$^3$) | $PM_{2.5}$ (µg/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.7 | 0.036 | 6.7 | 5.8 | 1.2 | 37 | 0.036 | 0.031 | 0.050 | 0.077 | 0.011 | 0.001 | 0.002 | 1510 | 782 | 58 |
| 2 | 1.6 | 0.029 | 29.7 | 10.0 | 14.7 | 12 | 0.003 | 0.081 | 0.042 | 0.112 | 0.047 | 0.002 | 0.002 | 528 | 402 | 54 |
| 3 | 0.7 | 0.048 | 13.8 | 6.7 | 8.6 | 70 | 0.035 | 0.048 | 0.042 | 0.062 | 0.117 | 0.002 | 0.001 | 856 | 669 | 90 |
| 4 | 0.5 | 0.032 | 1.8 | 1.8 | bd | 5 | bd | 0.017 | 0.016 | 0.031 | 0.008 | bd | bd | 6878 | 3981 | 284 |
| 5 | 0.9 | 0.021 | 1.9 | 1.9 | bd | 24 | bd | 0.070 | 0.020 | 0.076 | 0.060 | bd | 0.001 | 729 | 396 | 40 |

**Table A4: Operator's comments and weather conditions**

| Date | Site | Operator's Comments | Time | Temp °C | RH % | Wind km/hr | Wind Dir. |
|---|---|---|---|---|---|---|---|
| 23-Nov | 1 | Very light intermittent odours from plant. Drive slow towards and across bridge | 13:51 to 14:14 | 20.3 | 12.0 | 4.6 | SSE |
| | 3 | Downwind of both the Turner Valley historical plant and Talisman Energy plant | 14:14 to 15:16 | 18.8 | 13.2 | 4.0 | ESE |
| | 2 | Pick up odours at bottom of hill beside Sheep River. Very light wind from Turner Valley plant | 15:57 to 16:21 | 12.6 | 24.1 | 3.7 | SSW |
| 24-Nov | 3 | Pick up SO2 from Talisman Energy flare which is located on the west side of the Turner Valley gas plant | 13:44 to 14:00 | 21.0 | 14.1 | 4.4 | ENE |
| | 1 | Visit from Talisman personel and local resident | 14:20 to 15:20 | 19.6 | 16.2 | 4.7 | NE |
| | 1 | Visit from Talisman personel and local resident | 15:20 to 15:42 | 18.2 | 20.1 | 4.0 | SE |
| | 2 | Elevated RHC and CH4. Strong propane odour. Took grab sample with canister # 1155 | 15:[illegible] to 16:21 | 12.1 | 23.1 | 4.1 | S |
| | 4 | No RHC present upwind of Turner Valley plant | 16:41 to 16:48 | 9.9 | 25.1 | 8.4 | W |
| | 5 | No odours on north side of town | 17:21 to 17:33 | 5.6 | 37.1 | ND | ND |

**Table A2: Median one-minute average concentrations for monitoring sites in Turner Valley**

| Monitoring Location | CO PPM | $O_3$ PPM | THC PPM | $CH_4$ PPM | RHC PPM | PAH ng/m$^3$ | $SO_2$ PPM | NO PPM | $NO_2$ PPM | NOx PPM | $NH_3$ PPM | TRS PPM | H2S PPM | TSP ($\mu$g/m$^3$) | $PM_{10}$ ($\mu$g/m$^3$) | $PM_{2.5}$ ($\mu$g/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.1 | 0.026 | 1.8 | 1.8 | bd | 6 | 0.001 | 0.002 | 0.008 | 0.011 | bd | bd | bd | 120 | 86 | 10 |
| 2 | 0.2 | 0.023 | 10.4 | 7.2 | 2.7 | 5 | 0.002 | 0.003 | 0.010 | 0.013 | bd | bd | bd | 255 | 169 | 21 |
| 3 | bd | 0.032 | 1.7 | 1.7 | bd | 1 | bd | 0.002 | 0.003 | 0.005 | bd | bd | bd | 45 | 37 | 5 |
| 4 | 0.3 | 0.030 | 1.7 | 1.8 | bd | 1 | bd | 0.006 | 0.004 | 0.007 | 0.001 | bd | bd | 145 | 107 | 17 |
| 5 | 0.3 | 0.010 | 1.9 | 1.9 | bd | 16 | bd | 0.047 | 0.005 | 0.037 | 0.003 | bd | bd | 175 | 124 | 21 |

**Table A3: Maximum one-minute average concentrations for monitoring sites in Turner Valley**

| Monitoring Location | CO PPM | $O_3$ PPM | THC PPM | $CH_4$ PPM | RHC PPM | PAH ng/m$^3$ | $SO_2$ PPM | NO PPM | $NO_2$ PPM | NOx PPM | $NH_3$ PPM | TRS PPM | H2S PPM | TSP ($\mu$g/m$^3$) | $PM_{10}$ ($\mu$g/m$^3$) | $PM_{2.5}$ ($\mu$g/m$^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.7 | 0.036 | 6.7 | 5.8 | 1.2 | 37 | 0.036 | 0.031 | 0.050 | 0.077 | 0.011 | 0.001 | 0.002 | 1510 | 782 | 58 |
| 2 | 1.6 | 0.029 | 29.7 | 10.0 | 14.7 | 12 | 0.003 | 0.081 | 0.042 | 0.112 | 0.047 | 0.002 | 0.002 | 528 | 402 | 54 |
| 3 | 0.7 | 0.048 | 13.8 | 6.7 | 8.6 | 70 | 0.035 | 0.048 | 0.042 | 0.062 | 0.117 | 0.002 | 0.001 | 856 | 669 | 90 |
| 4 | 0.5 | 0.032 | 1.8 | 1.8 | bd | 5 | bd | 0.017 | 0.016 | 0.031 | 0.008 | bd | bd | 6878 | 3981 | 284 |
| 5 | 0.9 | 0.021 | 1.9 | 1.9 | bd | 24 | bd | 0.070 | 0.020 | 0.076 | 0.060 | bd | 0.001 | 729 | 396 | 40 |

**Table A4: Operator's comments and weather conditions**

| Date | Site | Operator's Comments | Time | Temp °C | RH % | Wind km/hr | Wind Dir. |
|---|---|---|---|---|---|---|---|
| 23-Nov | 1 | Very light intermittent odours from plant. Drive slow towards and across bridge | 13:51 to 14:14 | 20.3 | 12.3 | 4.6 | SSE |
| | 3 | Downwind of both the Turner Valley historical plant and Talisman Energy plant | 14:14 to 15:16 | 16.8 | 13.2 | 4.0 | ESE |
| | 2 | Pick up odours at bottom of hill beside Sheep River. Very light wind from Turner Valley plant | 15:57 to 16:21 | 12.6 | 24.1 | 3.7 | SSW |
| 24-Nov | 3 | Pick up SO2 from Talisman Energy flare which is located on the west side of the Turner Valley gas plant | 13:44 to 14:00 | 21.0 | 14.1 | 4.4 | ENE |
| | 1 | Visit from Talisman personel and local resident | 14:20 to 15:20 | 19.6 | 16.2 | 4.7 | NE |
| | 1 | Visit from Talisman personel and local resident | 15:20 to 15:42 | 18.2 | 20.1 | 4.0 | SE |
| | 2 | Elevated RHC and CH4. Strong propane odour. Took grab sample with canister # 2155 | 16:02 to 16:27 | 12.1 | 25.7 | 4.1 | S |
| | 4 | No RHC present upwind of Turner Valley plant | 16:41 to 16:48 | 9.9 | 25.1 | 8.4 | W |
| | 5 | No odours on north side of town | 17:27 to 17:33 | 5.6 | 37.1 | ND | ND |

# *Appendix B*

# *Alberta's Ambient Air Quality Objectives*

Alberta's Ambient Air Quality Objectives[1] are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta. The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health. Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored listed in Tables A5 and A6.

**TableA5: Alberta's Ambient Air Quality Objective measured by the MAML**

| Pollutant | One-hour AAAQO (ppm*) | Basis for Objective |
|---|---|---|
| Ammonia | 2 | odour perception |
| Carbon monoxide | 13 | oxygen carrying capacity of blood |
| Nitrogen dioxide | 0.212 | odour perception |
| Ozone | 0.082 | reduction of lung function and effects on vegetation |
| Hydrogen sulphide | 0.01 | odour perception |
| Sulphur dioxide | 0.172 | pulmonary function |

* parts per million

[1] *Alberta Ambient Air Quality Objectives.* Alberta Environment. April 2005.

**Table A6: Alberta's Ambient Air Quality Objectives (AAAQO) for Volatile Organic Compounds (VOCs)**

| Pollutant | One-hour AAAQO µg/m$^3$ | Basis for objective |
|---|---|---|
| Acetaldehyde | 90 | Adopted from Texas |
| Acetone | 5,900 | Adopted from Texas |
| Acrylic acid | 60 | Adopted from Texas |
| Acrylonitrile | 43 | Adopted from Texas |
| Benzene | 30 | Adopted from Texas |
| Isopropylbenzene | 500 | Adopted from Texas |
| Dimethiyether | 19,100 | Adopted from Texas |
| 2-Ethylhexanol | 600 | Adopted from Ontario |
| Ethylbenzene | 2000 | Adopted from Texas |
| Ethyl chloroformate | 0.57 | Stack emission limits |
| Ethylene | 1200 | Crop yield |
| Ethylene oxide | 15 | Adopted from Ontario's ½ hour POI[3] |
| Formaldehyde | 65 | Adopted from Texas |
| Isopropanol | 7,850 | Adopted from Texas |
| Methanol | 2,600 | Adopted from Texas |
| Styrene | 215 | Adopted from Texas |
| Toluene | 1,880 | Adopted from Texas |
| Xylenes | 2,300 | Adopted from Ontario |
| VinylChloride (Chloroethene) | 130 | Adopted from Texas |

**Notes:**

µg/m$^3$ = micrograms per cubic meter

[3] POI point of impingement

# *Alberta's Ambient Air Quality Objectives*

Alberta's Ambient Air Quality Objectives[1] are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta.
The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health. Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored listed in Tables A5 and A6.

**TableA5: Alberta's Ambient Air Quality Objective measured by the MAML**

| Pollutant | One-hour AAAQO (ppm*) | Basis for Objective |
|---|---|---|
| Ammonia | 2 | odour perception |
| Carbon monoxide | 13 | oxygen carrying capacity of blood |
| Nitrogen dioxide | 0.212 | odour perception |
| Ozone | 0.082 | reduction of lung function and effects on vegetation |
| Hydrogen sulphide | 0.01 | odour perception |
| Sulphur dioxide | 0.172 | pulmonary function |

* parts per million

[1] *Alberta Ambient Air Quality Objectives*. Alberta Environment. April 2005.

Table A6: Alberta's Ambient Air Quality Objectives (AAAQO) for Volatile Organic Compounds (VOC's)

| Pollutant | One-hour AAAQO $\mu g/m^3$ | Basis for objective |
|---|---|---|
| Acetaldehyde | 90 | Adopted from Texas |
| Acetone | 5,900 | Adopted from Texas |
| Acrylic acid | 60 | Adopted from Texas |
| Acrylonitrile | 43 | Adopted from Texas |
| Benzene | 30 | Adopted from Texas |
| Isopropylbenzene | 500 | Adopted from Texas |
| Dimethlyether | 19,100 | Adopted from Texas |
| 2-Ethylhexanol | 600 | Adopted from Ontario |
| Ethylbenzene | 2000 | Adopted from Texas |
| Ethyl chloroformate | 0.57 | Stack emission limits |
| Ethylene | 1200 | Crop yield |
| Ethylene oxide | 15 | Adopted from Ontario's ½ hour POI[3] |
| Formaldehyde | 65 | Adopted from Texas |
| Isopropanol | 7,850 | Adopted from Texas |
| Methanol | 2,600 | Adopted from Texas |
| Styrene | 215 | Adopted from Texas |
| Toluene | 1,880 | Adopted from Texas |
| Xylenes | 2,300 | Adopted from Ontario |
| VinylChloride (Chloroethene) | 130 | Adopted from Texas |

**Notes:**

$\mu g/m^3$ = micrograms per cubic meter

[3] POI point of impingement

## *The Mobile Air Monitoring Laboratory (MAML)*

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,
- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,
- an exhaust purifying system that minimizes emissions from the vehicle and
- two on-board generators that are also equipped with exhaust scrubbers

Table A7 lists the pollutants and meteorological data monitored by the MAML. Also indicated are the lower and upper detection limits for each monitored species.

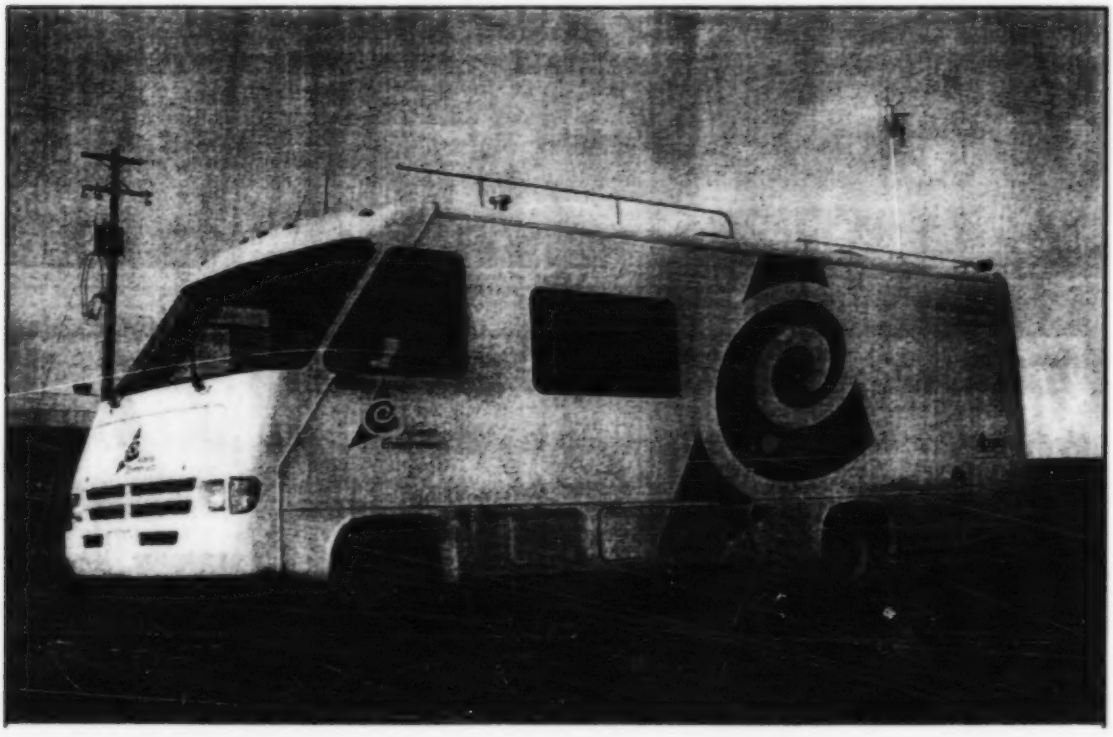

**Figure A1: Alberta Environment's Mobile Air Monitoring Laboratory**

**Table A7: Pollutants and meteorological data monitoring capabilities by the MAML.**

| Pollutant | Operating Range | |
|---|---|---|
| | Lower Detection Limit* | Upper Detection Limit** |
| Ammonia ($NH_3$) | 0.001 ppm | 5 ppm |
| Ozone ($O_3$) | 0.001 ppm | 0.5 ppm |
| Carbon Monoxide (CO) | 0.1 ppm | 50 ppm |
| **Hydrocarbons** | | |
| Methane ($CH_4$) | 0.1 ppm | 20 ppm |
| Reactive Hydrocarbons (RHC) | 0.1 ppm | 20 ppm |
| Total Hydrocarbons (THC) | 0.1 ppm | 20 ppm |
| Polycyclic Aromatic Hydrocarbons (PAH) | 3 $ng/m^3$ | 1000 $ng/m^3$ |
| **Oxides of nitrogen** | | |
| Nitrogen dioxide ($NO_2$) | 0.0006 ppm | 1 ppm |
| Nitric Oxide (NO) | 0.0006 ppm | 1 ppm |
| Oxides of nitrogen ($NO_x$) | 0.0006 ppm | 1 ppm |
| **Particulate Matter** | | |
| Total Suspended Particulates (TSP) | 1 $\mu g/m^3$ | 1.0 $g/m^3$ |
| Particulate Matter <10µm ($PM_{10}$) | 1 $\mu g/m^3$ | 1.0 $g/m^3$ |
| Particulate Matter <2.5µm ($PM_{2.5}$) | 1 $\mu g/m^3$ | 1.0 $g/m^3$ |
| **Sulphur Compounds** | | |
| Hydrogen Sulphide ($H_2S$) | 0.001 ppm | 1 ppm |
| Total Reduced Sulphur (TRS) | 0.001 ppm | 1 ppm |
| Sulphur Dioxide ($SO_2$) | 0.001 ppm | 2 ppm |
| **Meteorological data** | | |
| Wind Speed | 0 km/hr | 200 km/hr |
| Wind Direction | 0 degrees | 360 degrees |
| Temperature | -40 °C | 50 °C |
| Relative humidity | 0% | 100% |

**Notes:**

ppm - parts per million

$ng/m^3$ = nanograms per cubic meter

$\mu g/m^3$ = micrograms per cubic meter

$g/m^3$ = grams per cubic meter

* The ***lower detection limit*** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The ***upper detection limit*** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

Table A7: Pollutants and meteorological data monitoring capabilities by the MAML.

| Pollutant | Operating Range | |
|---|---|---|
| | Lower Detection Limit* | Upper Detection Limit** |
| Ammonia ($NH_3$) | 0.001 ppm | 5 ppm |
| Ozone ($O_3$) | 0.001 ppm | 0.5 ppm |
| Carbon Monoxide (CO) | 0.1 ppm | 50 ppm |
| **Hydrocarbons** | | |
| Methane ($CH_4$) | 0.1 ppm | 20 ppm |
| Reactive Hydrocarbons (RHC) | 0.1 ppm | 20 ppm |
| Total Hydrocarbons (THC) | 0.1 ppm | 20 ppm |
| Polycyclic Aromatic Hydrocarbons (PAH) | 3 $ng/m^3$ | 1000 $ng/m^3$ |
| **Oxides of nitrogen** | | |
| Nitrogen dioxide ($NO_2$) | 0.0006 ppm | 1 ppm |
| Nitric Oxide (NO) | 0.0006 ppm | 1 ppm |
| Oxides of nitrogen ($NO_x$) | 0.0006 ppm | 1 ppm |
| **Particulate Matter** | | |
| Total Suspended Particulates (TSP) | 1 $\mu g/m^3$ | 1.0 $g/m^3$ |
| Particulate Matter <10µm ($PM_{10}$) | 1 $\mu g/m^3$ | 1.0 $g/m^3$ |
| Particulate Matter <2.5µm ($PM_{2.5}$) | 1 $\mu g/m^3$ | 1.0 $g/m^3$ |
| **Sulphur Compounds** | | |
| Hydrogen Sulphide ($H_2S$) | 0.001 ppm | 1 ppm |
| Total Reduced Sulphur (TRS) | 0.001 ppm | 1 ppm |
| Sulphur Dioxide ($SO_2$) | 0.001 ppm | 2 ppm |
| **Meteorological data** | | |
| Wind Speed | 0 km/hr | 200 km/hr |
| Wind Direction | 0 degrees | 360 degrees |
| Temperature | -40 °C | 50 °C |
| Relative humidity | 0% | 100% |

**Notes:**

ppm = parts per million

$ng/m^3$ = nanograms per cubic meter

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* The ***lower detection limit*** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The ***upper detection limit*** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.